Pinnacles National Monument

Background Information

Location

The Monument occupies 24,000 acres in the southern portion of the Gabilan Mountain range, forty miles inland from the Pacific Ocean. The Gabilans lie in the center of northwest-trending parallel ridges and valleys that make up the central Coast Range. The park can be accessed from Hollister, 35 miles to the north of the park in San Benito County, or from the west through Soledad in Monterey County About 20 million people live within a 200-miles radius of the Monument, making it easily accessible to people living in the major California metropolitan centers of Los Angeles and the San. These incredibly mobile populations put increasingly higher recreation pressures on Pinnacles during weekends and holidays, especially in the spring, to enjoy cool temperatures, flowing streams and wildflowers.

Management objectives

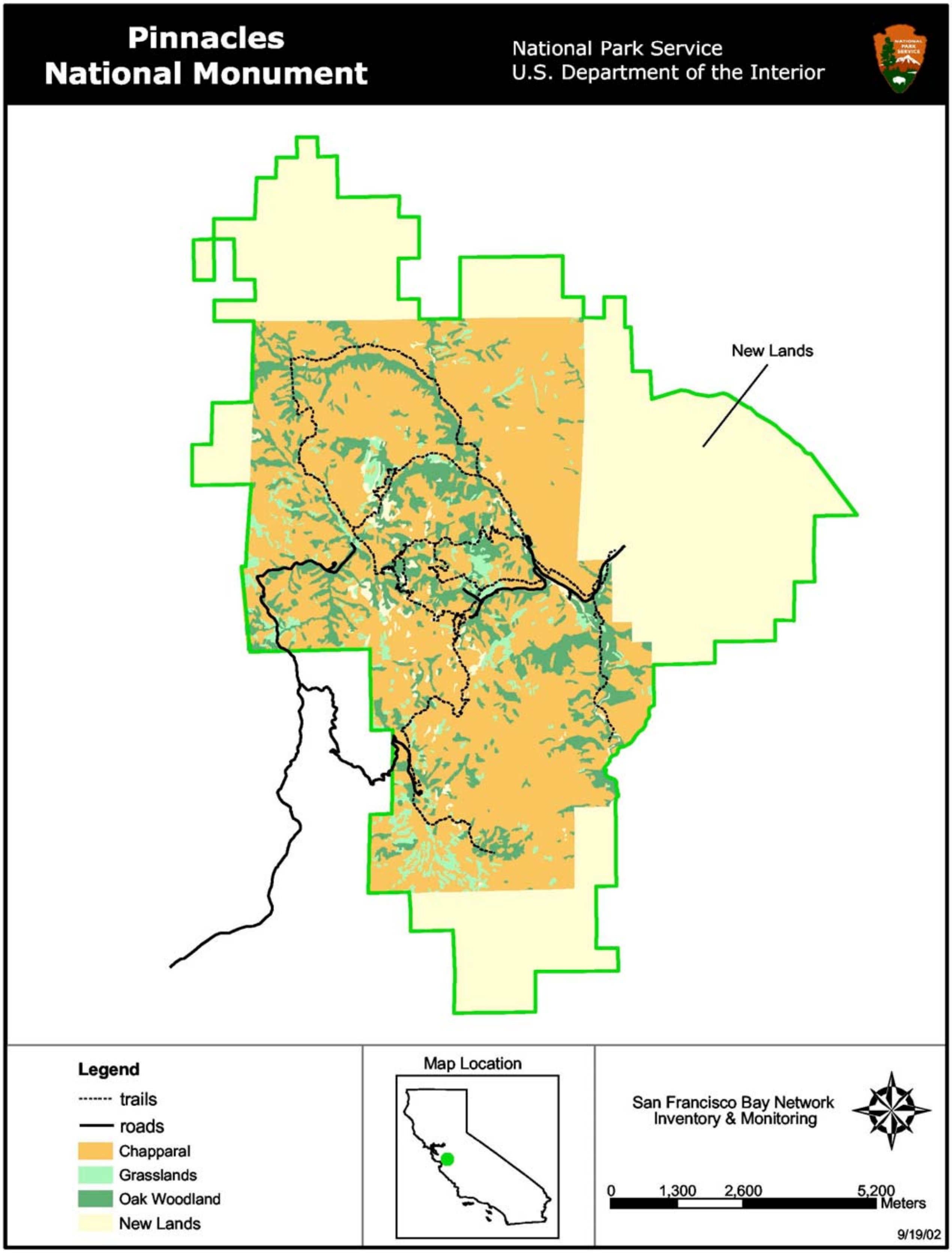
Natural resources are the primary focus of the park. The Monument was created for its exceptional geological resources in 1908 (35 Stat.217). It is notable that they were also reserved for their scientific interest. Therefore, the Inventory and Monitoring Program is a perfect “fit” to meet the need of gathering or documenting baseline information and developing long-term monitoring to understand condition and changes which continue to occur in the seismically active area.

> The purpose of the park is “to maintain natural and scenic resources of Pinnacles… (and) to manage them for optimal use, aesthetic inspiration, scientific study…” (Master Plan)

Pinnacles provides one of the few open spaces in the region with spectacular scenic views and opportunities for wildlife viewing. The monument is an important recreational destination. Its hiking trails and technical rock climbing are internationally known.

Activities to meet the long-term goals of preserving and protecting the wilderness, rocks, caves and associated values are listed in the park’s Strategic Plan (2000) to meet GPRA’s mission-driven focus. The goals and activities associated with natural resources are listed below:

1. Air quality at Pinnacles will remain stable or improve from 1998. In 1998, four days exceeded the daily standards established by EPA. The Monument will continue to collect data on visibility, ozone, and acid precipitation each week. The NPS Washington Office Air Quality Division will report all air quality conditions and trends for the park as part of a national program. (Goal Ia3)
2. Twenty-eight acres, disturbed by developments and agriculture, will be restored from 1997 levels. The three areas under consideration for restoration include the “YACC” administrative site, dumpsite, and climber access routes. Re-shaping the landscape, revegetation, and potential re-introduction of native wildlife may occur. (Goal Ia1a)



Vegetation Map. Surveys and mapping are underway in the newly acquired (tan) areas.

3. Understand 100% of the impacts of exotic plants and restore 20 acres to a natural state from 1997 levels. Non-native vegetation can result in severe and persistent changes in habitat conditions and ecosystem functions. The park plans to eradicate or reduce acreage impacted by five targeted species: slender-flowered thistle, yellow star thistle, bull thistle, summer mustard and white horehound. In 1997, 200 acres were known to be impacted by these plants. (Goal Ia1B)
4. Fifty percent of 16,015 acres of monument land impacted by feral pigs are contained from 1997 levels. Feral pigs pose a major threat to native plants, displace native animals from traditional home ranges, degrade water quality, and threaten riparian habitats and species. This project focuses on removing feral pigs from the monument. Specific activities include the construction of a 26-mile long fence around significant monument lands to keep pigs out, eventually followed by removal of pigs within the fenced area. (Goal Ia01B)
5. Twenty percent of the identified Monument's "Species of Special Concern" are at scientifically acceptable levels from 1997 levels.
    - California red-legged frog populations in the Monument have fluctuated in the last 25 years. Scientifically acceptable in this case means retaining population numbers sufficient for the park to maintain a viable population without regard to external populations. To fully protect this species, the exotic sun fish would have to be removed from the Monument.
    - Prairie Falcon
    - Western Pond Turtle
    - California Horned Lizard
    - Townsend's Big-eared bat (Goal Ia2X)
6. Museum collections will meet all standards for collection management. Museum collections include natural history specimens that document species presence at specific locations at specific times. All cultural landscapes, prehistoric sites and areas will be monitored and their integrity maintained to 1997 levels. Cultural landscapes and prehistoric sites provide the physical surroundings associated with historical events and reveal aspects of Pinnacle's history and prehistory. There are 29 known archeological sites of which 11 have been assessed and found in good condition.
7. Eighty percent of the park visitors will understand the purpose and significance of the monument from 1997 levels. This goal will be measured by visitor surveys to monitor success. Efforts to provide visitor information, orientation, interpretation, and education are park activities that help visitors make connections between the tangible natural and cultural resources and values that they appreciate.

Selected management objectives from the Master Plan can provide helpful guidance, even though this document is 27-years old and needs revision:

- ✓ Retain as much land as possible in a primitive, undeveloped category adhering to the standards for Wilderness classification.
- ✓ Identify and curtail human-initiated erosion and promote growth and reproduction of native vegetation as a stabilizing influence.
- ✓ Encourage research to develop a better understanding of the chaparral community.
- ✓ Eliminate feral animals.

Adjacent land uses

The surrounding area is rural in character with grazing, viticulture and truck farming as the primary land uses throughout the fertile Salinas and San Benito valleys. These agricultural valleys are home to many Mexican-American farm laborers who migrate following the crops. Although the immediate area is sparsely populated due to its hot, arid summer climate and rugged terrain, there is a rapid urban expansion toward Monument boundaries.

The park has concurrent jurisdiction with the State. Approximately 95% of the land is within San Benito County. Since the west side is remote from the San Benito sheriff's unit, Monterey County sheriff's frequently respond to more critical law enforcement needs.

Natural resources and scientific studies

Water resources

The main water drainage, Chalone Creek, begins in the northeast corner of the monument and winds in an outward spiral to the southeast corner. Eventually this waterway drains into the Salinas River to the southwest of the monument. Two other main drainages, Bear Gulch and the west fork of the Chalone Creek, bisect the pinnacles formations and helped create the two sets of caves found in the monument.

Pinnacles National Monument gets 16" per year on average. Most headwaters lie outside NPS boundary. With few exceptions, few creeks are ephemeral or intermittent. Because of the substantial water deficit in the summer, a large portion of winter precipitation is expended recharging soil moisture. The hydrologic system is very flashy. Soils and shallow aquifers drain rapidly due to their coarse material size. Stream base flow is minimal but may be fed by an aquifer that drains from Bear Valley towards the southwest. The shallow aquifer is easily altered by groundwater development within and outside the park. The location of perennial streams as well as the pattern of drying in the early summer likely has substantial ecological and habitat impacts. The timing and distribution of water flow is the result of a complex interaction between watershed vegetative cover, climate, riparian vegetation, stream geomorphology, groundwater and sediment budgets. Water quality is moderately degraded showing high levels of nutrients and pathogens due to development within and without the park boundary. Surface streams are well buffered having little likelihood of being impacted by acid rain or certain heavy metals.

Air/meteorology

The Monument has been placed in the Class I Air Quality category. Under the Air Quality Act (1977) Class I areas have the most severe restrictions, therefore should maintain the cleanest, most uncontaminated air. Typically Pinnacles has superb "Class I" air quality. Occasionally north winds and a persistent inversion layer draw air pollutants from the Santa Clara Valley into the Monument. The NPS Air Quality Office and EPA established a monitoring station near the east entrance in 1987. An air clarity study has been completed, but particulate and ozone monitoring continues. Despite the occasional hazy days, the air quality at the Monument is a defining feature and an important resource.

The climate of Pinnacles is typical of the Mediterranean climate of California, with cool wet winters and hot dry summers. Climate is determined more by distance to the ocean and elevation than by latitude. Despite the close proximity to the Pacific Ocean, the Coast Range modifies the influence of the ocean considerably. The average precipitation is approximately 16 inches per year. Nearly all of the precipitation is in the form of rainfall, with the majority occurring from December to March.

The Monument has an official weather station located at the base of Condor Gulch. This station has provided long-term data, but the spatial variation in weather and climate has not been researched. The air quality station also provides meteorological data, but is more recent in operation.

Geologic
Located on the eastern edge of the Pacific Plate, the park is an excellent example of tectonic plate movement. The rocks are believed to have originated in the Neenach formation, near present day Lancaster, California. This is 195 miles (324 km) south of the park's present location. The pinnacles have moved northward along the San Andreas Fault at a rate of approximately 1.5 inches (3.8 cm) per year. The Chalone Creek Fault, located within the park, is historically believed to have been the main line of the San Andreas Fault, now located 4 miles (6 km) to the east. The history of faulting and earthquake movement has created deep, narrow gorges where huge boulders have toppled from higher formations and become wedged forming talus caves.

The pinnacle rocks are remnants of a Miocene volcano that is in an advanced stage of decomposition. Approximately 23 million years ago, rhyolitic magma and other flows were forced to the surface through fissures in a basement of quartz diocite and granite. Later activity developed central vents, and explosions from these vents built up a vast thickness of pyroclastics above the earlier lavas. The action of erosion, the work of water and wind on these pyroclastics, has given rise to the unusual and scenic effects for which Pinnacles is famous. The rhyolitic volcanics weather and erode much faster than granitics and sandstone.

Seismic activities in the Monument continue to be monitored by the US Geological Survey. There is a seismonmeter along the Chalone Creek Fault and a corresponding seismograph in the Beach Gulch Visitor Center that provides a continuous record of seismic activity. The purpose of continued monitoring is to learn more about earthquake phenomena. The information provides staff with data to illustrate and interpret the natural processes still shaping the Pinnacles.

Vegetation

Vegetation at Pinnacles National Monument may be broadly grouped into five major vegetation classifications: rock and scree, grasslands, riparian, woodlands and chaparral. The patterns are a result of influence of factors, such as soil type, exposure, slope, moisture regime and fire history, on the vegetation types.

Rock and Scree. This community is characterized by having extremely shallow, or absent, soils and plants with the ability to colonize these primitive habitats. This community is found mainly in the High Peaks and balcony areas of the park.

Grasslands**.** This association is the least well understood of the vegetation communities in the Monument.

Riparian**.** Riparian areas are restricted to the valley bottoms and sheltered moist canyons of the Monument. This association, although not one of the largest in terms of land area (10%), is a crucial habitat for many plant and animal species throughout the Monument.

Woodlands. Woodlands are the second most common association. Trees with an annual grass and forb understory characterize this vegetation type. The main woodland association at Pinnacles is the blue oak woodland, comprising 10% of the total vegetation cover in the Monument. The oak woodlands have a high percentage of native species. Feral pigs, fire, non-native grass competition and climate probably affect oak regeneration. For the most part, regeneration is occurring but may not be common. We believe oak regeneration is episodic, sporadically over large time scales, much larger scales than we can detect within our lifetime. Oak woodlands within the monument do have higher percentage of non-native grasses as compared to grasslands or as compared to oak woodlands outside Pinnacles.

Chaparral. Chaparral is the dominant plant community. Various types of chaparral cover 82% of the Monument. Chaparral can thrive in areas with harsh climatic conditions where other plants would not be able to survive. Most of the plants in this association are fire-tolerant. Many plants will only sprout after fires occur or may sprout from seeds that have been dormant for years. Chaparral is dominated by chamise, buckbrush, manzanita, holly-leaved cherry, mountain mahogany and black sage. Distribution of these various types can vary depending on exposure and soil type.

Unique Vegetation Components:

The rocks provide habitat for both moss and lichen specimens. Little information is known about the species composition or structure of these communities, but diversity is believed to be high based on preliminary studies Currently there are no federal or state listed plant species known to occur within Pinnacles. There are some plants that are on the California Native Plant Society list 1B, and list 4. New lands added to the Monument and increased survey intensity may reveal the presence of some rare species.

Relict species are those that have disjunct populations or are otherwise removed from the typical species distribution. Pinnacles contains species that would normally be found both in the Sierran foothills. and species that would normally be found in the Coast Ranges.

Wildlife

Wildlife assemblages are well represented. Native diversity (species richness) is high and seems to be relatively even with few exotics. There are 49 mammals, 30 reptiles/amphibians and 148 bird species documented in the park, yet there are many gaps in baseline information.

Very few endemic species occur in the park, examples are the big-eared kangaroo rat and Gabilan salamander. Few non-native animal species occur within the park: feral pigs, house mouse (may be extirpated), opossum, wild turkey, chukkar, starling, and house sparrow. The park is dependent on areas outside the park boundary for habitat to support wildlife. Animal populations can be categorized into 3 main sets of sustainability. First, we have populations that have certain elements of their life cycle within the park, but need elements outside the park to continue to survive. A prime example of this is raptors, such as prairie falcons, which have sufficient nesting habitat, but do virtually all of their foraging outside the park boundary. Second, we have populations that have all their life elements in the monument, but do not have high enough numbers to be sustaining; they need connections to other metapopulations for continued success. Examples of this set would include frogs and toads. Third, we have animals that have too few individuals to be considered a sub-population. Examples include mountain lions or badgers, which cannot fit a single territory within the park. Maintaining connections to populations outside the park is mandatory for these species to continue to exist within the park.

<u>Threats and stressors to natural resources</u>

Pinnacles is still under rapid change, in the geologic sense. Often we glimpse episodes of landscape change. These changes are usually catastrophic, not gradual. Disturbance can be natural or artificial (human caused). Artificial disturbances have some important differences from natural ones. Foremost, feedback mechanisms that return the system to a pre-disturbance state are more likely to exist for internal/natural disturbances than external/artificial disturbances. The workshop summaries have greater detail on stressors and threats.

The park is a dynamic system. With active faulting and earthquakes and a variety of types of mass wasting, the landscape and biota continually adjust and change. The following reflect the major disturbances to natural resources in the park:

1. Erosion
2. Fire. The fire interval is between 40-100 years. Fire frequency has probably not changed dramatically in the last 200 years. Use of fire by native Americans during the Holocene was probably not significant since Pinnacles National Monument was only seasonally occupied for collection off all acorns, spring bulbs. During the last 100 years, fires were probably natural ignitions during the hotter period of the year since the park has a lot of chaparral and few weeds. Prescribed burns in the 1970's and early 1980's during the winter created vegetation type conversions to non-native grassland. (Concern: prescribed fire cannot replicate natural fire and burnt areas become vectors of non-native plant invasions). Although some species are fire dependent (fire poppy), most species are fire tolerant or fire adapted which allow them to survive fire but not need it.
3. Flooding
4. Mass Movement
5. Meteorological Hazards (El Nino, Global Warming…)
6. Non-Native Species Invasions
7. Seismic Activity

WORKSHOP SUMMARIES FOR CONCEPTUAL MODEL AND POTENTIAL VITAL SIGNS INDICATORS

Pinnacles National Monument

Two workshops were held to review natural resources information, conceptualize how they were affected by disturbances and anthropogenic stressors, and brainstorm potential vital signs monitoring indicators. The second focused on pulling the information together into a conceptual model. Both workshop summaries are included.

WORKSHOP OBJECTIVES:

1. Write down assumptions and develop a conceptual model.
2. Identify stressors, anything that can affect park resources.
3. Brainstorm potential vital signs monitoring questions, indicators, and sketch out how the monitoring could be accomplished.

Park staff provided current knowledge about the natural resources, the forces of change, and the management issues during a walk through the park and in a meeting room. Discussions were lively, punctuated with information from the convened researchers and specialists. The group concurred with the stressor list that park staff provided. Three smaller working groups worked on the vital signs monitoring signs and indicators based on three major resource types: physical, vegetative and wildlife resources. The group reunited to look at common linkages between the potential monitoring needs and the characteristics of a good vital signs monitoring program.

POTENTIAL GOALS FOR NATURAL RESOURCE MONITORING:
This was based on the park enabling legislation, other legal mandates and the workshop discussions.

1. Protect pinnacle rocks and caves and associated biota. These are considered primary park resources and a reason the park was created.
2. Preserve wilderness values including natural quiet and dark.
3. Maintain good air quality and visibility.
4. Protect threatened and endangered species and preserve their habitat.
5. Preserve natural processes. Habitat patches in the park create a high diversity of species.
6. Maintain native plants. Since there has been little unnatural disturbance, there is a high percent of native plant species.
7. Conserve necessary migratory corridors and habitats. Many park animals require a larger space than occurs within the park boundary.

SUMMARY OF STRESSORS (in decreasing order of social impact):

1. Development/land use (internal and external of the park boundary): air and water pollutants, water quantity, light, ingress of exotic species, decrease in migratory corridors
2. Visitor use: noise, wildlife distribution and reproduction, habitat fragmentation, social trails and loss of vegetative cover, soil erosion).
3. Exotic species: competition with native species, loss of diversity, change in vegetation community structure and wildlife)
4. Wildland fire (natural ignition frequency every 40-100 years): vegetative cover, wildlife, erosion
5. Flood: catastrophic change and sediment loss
6. Climate: global warming
7. Geology: uplift and movement northward, earthquakes

INFORMATION GAPS AND INVENTORY NEEDS:

Inventory Needs:

- Mass wasting and landslide potential. Management concern: safety. Map historic slides and develop a model of potential hazard zones.
- Soil map. Management concerns: effect of fire lines, location of trails, rehab efforts. Inventory the soils throughout the park, characterize soil geochemistry, water holding capacity and erosion potential.
- Caves. Management concern: visitor use, rare species. Inventory cultural, biological, hydrological and atmospheric resources in significant caves.
- Natural soundscape. Management concern: visitor use, wildlife. Do a baseline measurement.
- Bats. Management concern: rare species, visitor use, and distribution.
- Earthworms. Management concern: presence of a non-native earthworm.
- Wildlife disease. Management concern: health and safety. Determine the

presence/absence of Hanta virus and Lymes disease.

- Lichens. Management concern: air pollution, visitor use.
- Rare plants. Management concern: How are sensitive plant species distributed within Pinnacles
- What was the original vegetation on the Pinnacles Ranch?
- What is the distribution of mistletoe in the Monument?

Research Needs:

- What is the nutrient flow through the park and how does fire affect it?
- What are the microclimates in the different ecosystems? Move four portable Meteorological stations to different areas of the park once every year.
- What is the sedimentation rate in the reservoir?
- What effect do the bolts and chalk have on the rocks?
- Do social trails have an effect on geophysical resources? (compaction, increased erosion)
- What effect is noise having on natural quiet and biological resources?
- What effect is human sanitation off trails having on water quality and other resources?
- What is the water quality entering the park?
- What effect do land use changes (maintenance activities, restoration activities) within the park have on geophysical processes
- What are the biological and geochemical effects of air pollutants (ozone)?
- What is the flushing distance for selected species of birds?
- What are the impacts of the non-native turkey, what do they eat, reproductive rates?
- What are the impacts of starlings to cavity nesters?
- Would the distribution of gray pines be an appropriate vital signs indicator? that is sensitive to fire, flood or air pollution?
- What are key pollinators for important native plant communities?
- What is the carrying capacity for visitors by trail, climbing route, etc.?
- Do existing or impending exotic species have geophysical effects, including flora and fauna?
- How do feral pigs modify nutrient cycling, soil development and erosion?
- What effects to the pig fence have on channels that it crosses.
- What impacts to pigs have on biological systems – specifically salamanders, earthworms, vegetation – looking inside and outside fence?
- What affect does the fence have on limiting the distribution of species, both plant and animal?
- What species are truly affected by pigs?
- How are pollutants affecting biological and physical systems in the rock/scree community?

POTENTIAL IMPORTANT LINKAGES

In order to attempt to correlate the information into a vital signs monitoring scheme, the discussion was expanded to examine linkages between the specific components of the ecosystem that each of the three groups had identified. Sampling design similarities became the primary means of linking different project types. Other linkages were based on the need and method for sharing data to expand the area of focus and the need to document events and visitor use for effects to the resources.

1. The **matrix grid system** of establishing sampling locations could be used for various monitoring schemes for terrestrial resources. It was agreed that this system was better than a stratified survey design, since the monitoring goal is to measure change over time. Multiple disciplinary teams could look at a variety of resources under this sampling design. Even though timing of monitoring for each resource type may not be the same, compiling more than one type of information at each sample point would result in data layering and a very robust data set.

   Resources that could be monitored include:
   a) animal occurrence using an array for different taxa (small mammals, herps, invertebrates (bees and other pollinators), birds)
   b) vegetation (bare ground, herbs, shrubs, trees for cover, species richness…)
   c) geology (soil type, slope, ground moisture content…)
   d) climate (temperature, relative humidity, rainfall)

   Issues that could access this information to improve understanding and assist management decision-making include:
   a) fire effects mapping
   b) flood effects mapping
   c) spread of exotic plants and change in population size
   d) plant species occurrence at the edge of their range
   e) plant species occurrence becoming rare
   f) oak mortality
   g) triggers for landslide and erosional areas
   h) sediment budget in watersheds
   i) compliance document preparation and comments for projects

2. **Riparian area monitoring** would need a different monitoring scheme, perhaps along the line transect concept, but may be able to incorporate points from the matrix grid system. Multidisciplinary groups could also be used.

Areas of study could include:
a) surface water quality and quantity
b) vertebrate animal demography, especially amphibians (frogs)

c) invertebrate indicator species (indicators of presence of pollutants)
d) sediment budget

Issues that could use this information include:
a) sanitation and effects of campgrounds, septic systems…
b) developmental changes to the watershed shape and sediment budget
c) presence and effects of exotics
d) presence of pollutants
e) change in water use patterns
f) potential for flooding and landslides

3. The **aerial photograph/GIS system** captures more regional scale information that could be used to monitor the following:
a) gross vegetation community change
b) landuse of external neighbors and gross landscape change
c) exotic plant communities that have a specific signature detectable with aerial mapping
d) wildlife corridor connectivity
e) habitat fragmentation
f) recovery and habitat change after catastrophic events such as fire, flood, landslide

Uses of this type of information could be helpful in resolving these issues:
a) impacts from external land use
b) source locations for exotic species ingress
c) changes to stream flow upstream of the park
The issue of scale and size of the core area were not determined.

4. **Air quality** is already being monitored at three locations within the park. In order to understand regional level issues, stations outside the park could be identified and included. Air quality effects to include monitoring of sensitive species such as lichens. On a more local scale, internal sources of air pollutants could be documented. Monitoring of lichens could also provide information about recreational rock climbing effects.

5. Documentation of **catastrophic events** that have the capability of ecosystem-level change was thought to be an important aspect of the monitoring across all resources. Seasonality, intensity, duration and area of each event was thought to be important for:
a) fire
b) flood
c) landslide
d) ground disturbance in/around a riparian area

6. Documentation of **visitor use** was also thought to be important. Both number of visitors and type of use could be documented for various selected

areas of the park. Some of the matrix locations may be included as locations.
Visitor uses included:
a) hiking
b) climbing
c) driving

Resource affects from visitor use could include:
a) soil compaction and erosion related to trails
b) vegetation trampling adjacent to trails
c) number of social trails
d) climbing impacts to the Pinnacle rocks from pitons…

7. A few specific **issue-driven topics** did not fit neatly into one of the above but were thought to be important:
a) spread of disease and oak mortality
b) rate of groundwater mining within and around the park
c) nest parasitism (nest searches for 5 bird species)
d) raptor species demography could expand to include more than just the falcons using the Pinnacle rocks

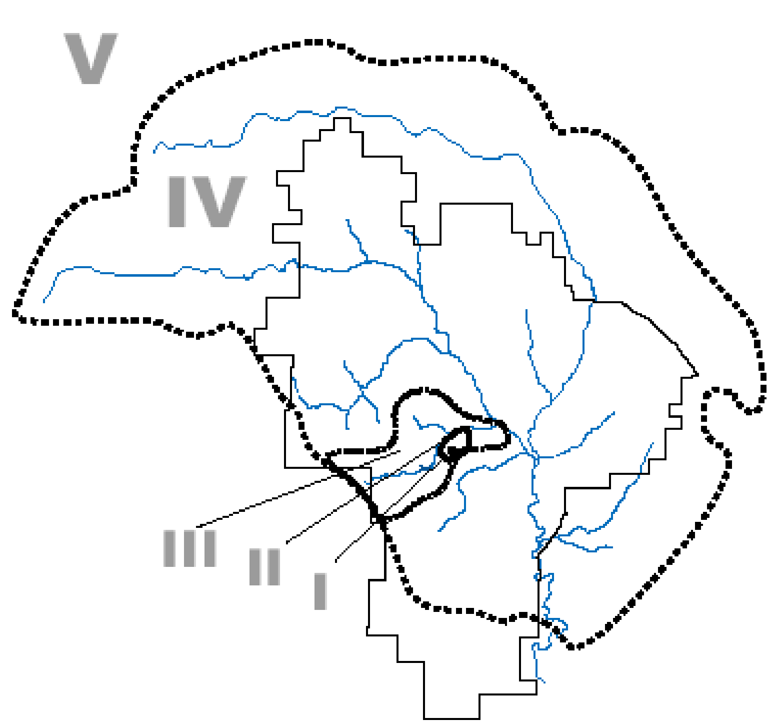
8. Linkages included communication and sharing of information with park neighbors and other agencies to improve stewardship and protection of resources. These groups included:
a) agricultural neighbors
b) California Fish and Game
c) Fish and Wildlife Service
d) the many University researchers
e) the San Francisco Bay network of park specialists other monitoring sources along migratory corridors

Conceptual model workshop summary

<u>Assumptions and selection criteria</u>

A vital sign indicator is any measurable feature of the environment that provides insight into the state of the ecosystem. The purpose of a long-term monitoring program is two-fold. The first goal of this program is to develop scientifically sound information on the status and trends in the composition, structure and function of ecosystem components and the entire ecosystem. The second goal is to determine how well current management practices are sustaining the ecosystem and its components. Recognizing that it is impossible to measure all elements, the constituent components to be used as vital sign indicators must be chosen. The process for determining which ecosystem components would be vital sign indicators for the long-term monitoring program began with the Vital Signs Workshop held in September 2001. This workshop produced a list of numerous potential topics as indicators and made suggestions for methodologies. Additional consultations were made with individuals who could not attend the workshop. In order to prioritize and narrow the desired indicators, the following selection criteria were used as well the experiences and accumulated time of park resource management staff in Pinnacles, more than 25 years. The monitoring indicator should:

1. Have low impact to resources and the environment
2. Have measurable results that are repeatable with different personnel
3. Be accurately and precisely estimated (low natural variability)
4. Be cost efficient
5. Be distributed over a wide geographical area and/or is very numerous
6. Have dynamics that parallel those of the ecosystem or component of interest
7. Be able to provide an early warning of change (allowing management intervention)
8. Have dynamics attributed to either internal (natural variation) or external (human caused) stressors
9. Have results that can be interpreted and explained (meaningful)



Scale	Name	Size	Scale Synonyms	Examples
I	Habitat	20 m	Patch	pheobe nest territory
II	Community	200 m	Vegetation type	chamise chaparral unit
III	Sub Watershed	5 km	Landform	Bear Gulch drainage
IV	Watershed	20 km	Park Boundary, aquifer	Chalone Creek
V	San Benito Co	50 km	Mountain range	SCoRI floristic subregion
VI	Cen Coast Ranges	100 km	Region, ecoregion	Salinas river, Salinian Block
VII	Coast Ranges	500 km	Csa climate type	Mediterranean- mild winter
VIII	California	1000 km	Floristic province	California
IX	Western Province	2000 km	Pacific cordilliara	subduction geology controlled
X	Global	20000 km	Planetary	Earth

In a larger context, Pinnacles is part of the California province and its various ecoregions. California has more natural diversity than any other temperate region. The Mediterranean climate that dominates the weather pattern is known for its year to year variation, long periods of drought and rain, and microclimates. Successively larger spatial scales exert a diminished influence upon a particular point, and exert influence over a longer time scale. These nested spatial scales can be articulated by a hierchical system (Figure 1). The smallest spatial scale, level I, is synonymous with a patch of annual shrubs, a stand of trees, a phoebe nest territory, or an outcrop of rock. Another ways of describing this is an area approximately 20 meters across. The second level is the community level, also synonymous with a first order landform, habitat area, or an area 200 meters across. This pattern continues upwards with level 3 (sub watershed/second order landform), level 4 (watershed), level 5 (mountain range/floristic subregion), level 6 (ecoregion), level 7 (climate type), level 8 (floristic province/State of California), level 9 (continental geology province), and level 10 (global). Each level increases in spatial scale as well as signifies larger connections to neighboring areas.

In addition to the criteria above, each indicator was rated related to two other aspects. First, it was evaluated as to whether it would be better to measure a resource value (stressee) or stressor. Often resource values are chosen over stressors because they are more interesting and fun to study. Our selections tried to account for which study would provide the most information on the ecosystem function. Second, how long it would take to detect a trend was considered. Our selections tried to provide quick results. However, some indicators were kept even though there is a long time before trend data would be available for analysis. In these instances (oaks for example), the resources had a very high intrinsic value (and a high socio-political interest) and the monitoring methodology is not expected to be every expensive or time consuming. For several of the chosen indicators, data was available to assess each of the above qualities, however, current knowledge is not "perfect" and the use of "best educated guesses" was required in some instances.

<u>Definitions for vital sign descriptions</u>
For each vital sign indicator (to follow), a set of descriptors is listed which are defined here.
Type: represents whether the indicator is a basic resource component/value or if the indicator is a stressor within the system, or in some cases if the indicator is both.
Metric(s): refers to what elements will be measured, what data will be collected on this indicator.
How: provides a short description of a methodology or will reference a developed protocol.
Frequency: stipulates how often the indicator needs to be measured. The proposed frequencies for each indicator will likely be decreased over time. Monitoring, needs to begin with over-sampling in time, space, and intensity to be able to detect change.
Timing: specifies the time of year that data collection should occur.
Scale: Three scales will be identified: 1) indicates at what level the data will be collected in our nested spatial system, 2) on what scale the process or element operates on and 3) at what scale can our analysis be inferred.

Why: provides a simplified justification as to the importance of measuring this indicator.
Basic Assumptions: specifies the underlying assumption(s) that if not true, would possibly invalidate this indicator/methodology combination.
Research Need(s): identifies any known research need(s) that would facilitate our understanding of how this indicator fits within the ecosystem model.
Management Goal: this is the desired future condition.
Threshold/Target Value: stipulates the resource condition (numerically if possible) and the amount of variation from this condition that will be tolerated (accepted as natural variation).
Management Response: specifies what management action will occur if the threshold or target is not met.
Concerns: lists issues raised about this indicator related to its successful implementation.
Status: identifies whether this monitoring is proposed, in development, or on-going.

<u>Potential Indicators</u>

Resilience monitoring (fire)
Type: resource value
Metric(s): vegetation recovery – species presence/absence, density, height, relative abundance, native:exotic ratio; hymenoptera – species presence/absence; soil properties – infiltration rate, microbe species, pH, (get more), wildlife recovery -- small bird point count, trailmaster photo points,
How: protocol to be developed
Frequency: event based initiating, then annually for 5 years
Timing: immediate post event, then spring for annual monitoring
Scale: data collection II-III operates on II-V analysis inference IV-V
Why: want to detect global impacts on ecosystem, primarily climate change
Basic Assumptions: if everything is "okay", then chaparral goes back to chaparral in about 5 years and continues. But if global, large-scale change is looming and only adults remain as relicts, when fire goes through the area species cannot replace themselves resulting in a type conversion that would then be detected
Research Needs: none at this time
Management Objective: maintain current species compositions within natural range of variability maintain disturbance regime within natural range of variability
Threshold/Target Value: not sure change in top three dominant species composition
Management Response: not sure educate the public on ecosystem resilience and projected changes of the PNM ecosystem
Concerns: if change is detected it will be "too late" to do anything about climate change
Status: proposed

These descriptors were used to develop monitoring for the following indicators

- Resilience Monitoring (flood)
- Catastrophic Event Monitoring (Fire, Flooding, Mass Movements, Earthquakes, Disease/Die-off)
- Feral Pigs and Pig Damage
- Vegetation Associations (stand level scale)

Landuse Change (landscape scale)
Weather
Prairie Falcons
Ground Water
Small Bird Counts
MAPS – Bird Banding Station
Air Quality
Exotic Plants
Townsend's Big-Eared Bats
Light Pollution
Oaks
Exotic Fish
Black-tailed Deer
Coast Horned Lizard

A complete list of the descriptors will be included in the Phase II report.

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For
VITAL SIGNS BACKGROUND INFORMATION

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